

## 5 What is claimed is:

1. A series of cyclonic devices suitable for use in the contacting of vapor and liquid in a distillation or fractionation process, wherein each device comprises:

- 10 (a) a floor;
- 15 (b) a continuous side wall having an upper end and a lower end, said lower end terminating into said floor, said upper end defining an upper cyclonic region which may be adjacent to the floor of another cyclonic device, and said side walls defining a contacting volume above the floor and below the upper cyclonic region;
- 20 (c) at least one vapor opening in said floor through which vapors can flow into said contacting volume;
- 25 (d) at least one liquid downcomer comprising:
- (1) downcomer side walls having an upper portion and a lower portion, said upper portion being located in the upper cyclonic region, and said lower portion extending to a point above the cyclone floor and having a lower portion end;
- 30 (2) at least one downcomer port located proximate to the lower portion end of the downcomer, said port defining an opening in said downcomer side walls through which liquid can flow;
- (e) at least one liquid outlet located on one side wall, said liquid outlet defining an opening in said side wall through which liquid can flow;
- 35 (f) at least two sets of devices to impart spin to the vapor and entrained liquid wherein at least one liquid outlet of (e) is located on the side wall between the first set of spin devices and the second set of spin devices.

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2. A series of cyclonic devices suitable for use in the contacting of vapor and liquid in a distillation or fractionation process, wherein each device comprises:

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(a) a floor;

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(b) a continuous side wall having an upper end and a lower end, said lower end terminating into said floor, said upper end defining an upper cyclonic region which may be adjacent to the floor of another cyclonic device, and said side walls defining a contacting volume above the floor and below the upper cyclonic region;

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(c) at least one vapor opening in said floor through which vapors can flow into said contacting volume;

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(d) at least one plenum, located near the floor of the cyclonic device, through which liquid may enter the cyclone;

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(e) at least one liquid outlet located on one side wall, said liquid outlet defining an opening in said side wall through which liquid can flow;

(f) at least two sets of devices to impart spin to the vapor and entrained liquid wherein at least one liquid outlet of (e) is located on the side wall between the first set of spin devices and the second set of spin devices.

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3. A series of cyclonic devices suitable for use in the contacting of vapor and liquid in a distillation or fractionation process, wherein each device comprises:

(a) a floor;

(b) a continuous side wall having an upper end and a lower end, said lower end terminating into said floor, said upper end defining an upper cyclonic

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5 region which may be adjacent to the floor of another cyclonic device , and said side walls defining a contacting volume above the floor and below the upper cyclonic region;

10 (c) at least one vapor opening in said floor through which vapors can flow into said contacting volume;

(d) at least one tray located outside the continuous side wall, through which liquid enters the cyclonic device at or near its floor,

15 (e) at least one liquid outlet located on one side wall, said liquid outlet defining an opening in said side wall through which liquid can flow; Scott-I'm not quite clear on this concept

20 (f) at least two sets of devices to impart spin to the vapor and entrained liquid wherein at least one liquid outlet of (e) is located on the side wall between the first set of spin devices and the second set of spin devices.

25 4. The series of cyclonic devices recited in claim 1, claim 2, or claim 3 wherein there are no devices to impart spin located at the floor of a cyclonic device.

5. The series of cyclonic devices recited in claim 1, claim 2, or claim 3, wherein at least one outlet is located on at least side wall between the initial set of spin devices and the second set of spin devices.

30 6. The series of cyclonic devices recited in claim 1, claim 2, or claim 3 , whereby said cyclonic devices are connected in such a way that the sidewalls of adjacent cyclonic devices contact each other to an extent and the sidewalls also define an opening between adjacent cyclonic devices.

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- 5 7. The series of cyclonic devices of claims 1, 2 or 3 wherein the side walls of the cyclonic device side walls form a shape selected from the group consisting of cylindrical, conical, hexagonal or octagonal.
- 10 8. The series of cyclonic devices of claims 1, 2 or 3 wherein one set of devices to impart spin is located near the middle of the elevation of each cyclonic device
9. The series of cyclonic devices of claims 1, 2 or 3 wherein one set of devices to impart spin occupies 5-25% of the elevation of each cyclonic device.
- 15 10. In a process for fractionating, distilling, or the like, the improvement comprising:
- (a) providing a vertical column having surrounding sidewalls;
- 20 (b) feeding a first and a second fluid into the column, wherein the first fluid is in its vapor state and the second fluid is in its liquid state within the column;
- 25 (c) directing the first and second fluids to flow through a series of cyclonic devices located within the column, each cyclonic device comprising:
- (1) a floor;
- 30 (2) a continuous side wall having an upper end and a lower end, said lower end terminating into said floor, said upper end defining an upper cyclonic region which may be adjacent to the floor of another cyclonic device, and said side walls defining a contacting volume above the floor and below the upper cyclonic region;
- 35 (3) at least one vapor opening in said floor through which vapors can flow into said contacting volume;

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(4) at least one liquid outlet located on one side wall, said liquid outlet defining an opening in said side wall through which liquid can flow;

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(5) at least two sets of devices to impart spin to the vapor and entrained liquid, wherein at least one liquid outlet of (4) is located on the side wall between the first set of spin devices and the second set of spin devices;

(d) also directing said fluids to flow through a plurality of liquid downcomers comprising:

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(1) downcomer side walls having an upper portion and a lower portion, said upper portion being located in the upper cyclonic region, and said lower portion extending to a point above the cyclone floor and having a lower portion end;

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(2) at least one downcomer port located proximate to the lower portion end of the downcomer, said port defining an opening in said downcomer side walls through which liquid can flow;

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whereby the vapors present within said column flow upward from one cyclonic device to the next through said vapor openings and the liquid present within said column flows downward from one cyclonic device to the next by passing through said liquid outlet and through the downcomers, and whereby the liquid and vapor contact each other in a co-current fashion within the contacting volume of the cyclonic devices.

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B2

Add D2

Add E1